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The potential of new global soil maps

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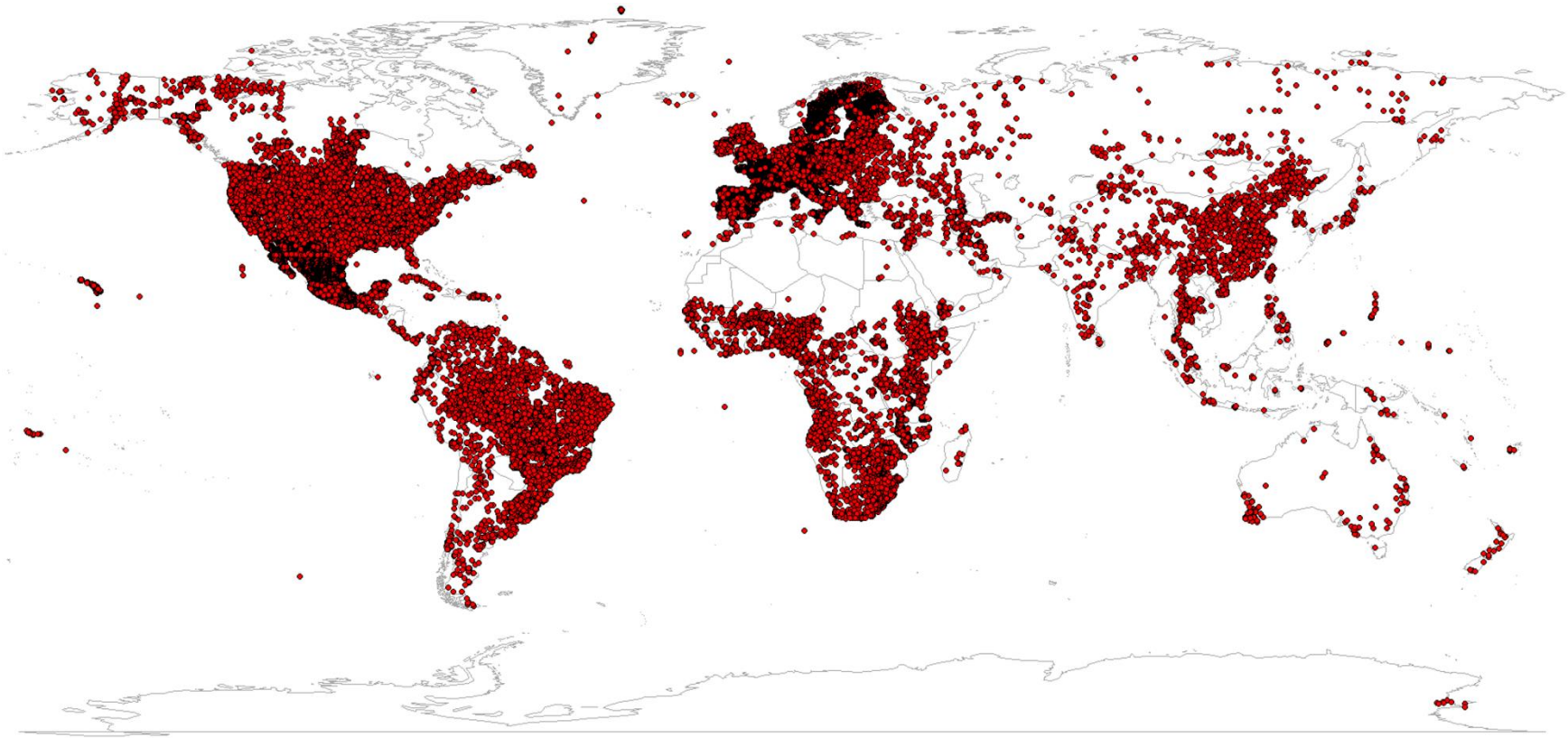
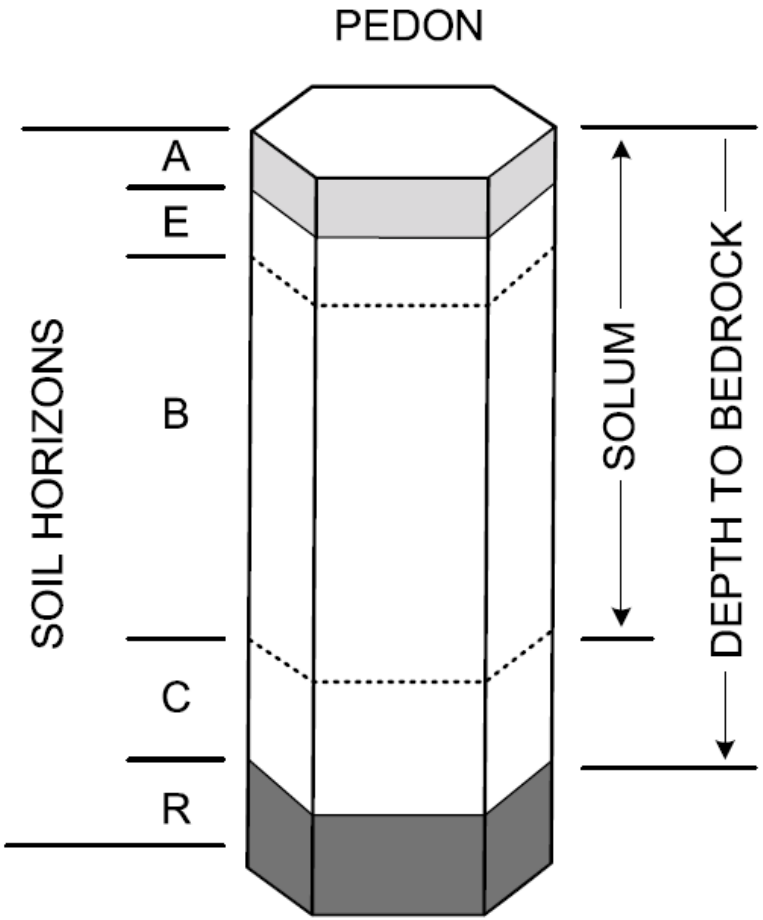
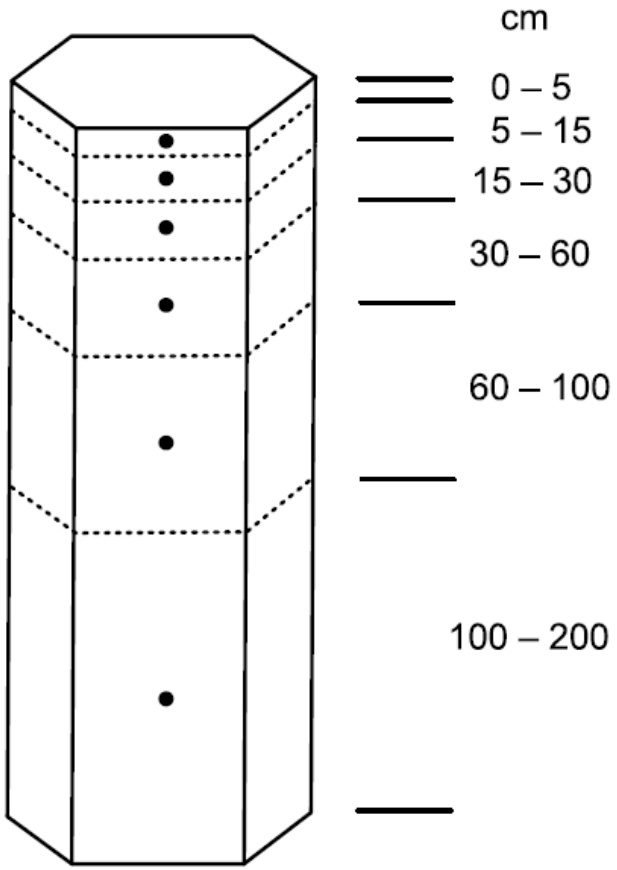
SoilGrids1km soil sample basis



World distribution of soil profiles used to generate the SoilGrids1km product - about 110,000 points (Hengl et al., 2014)

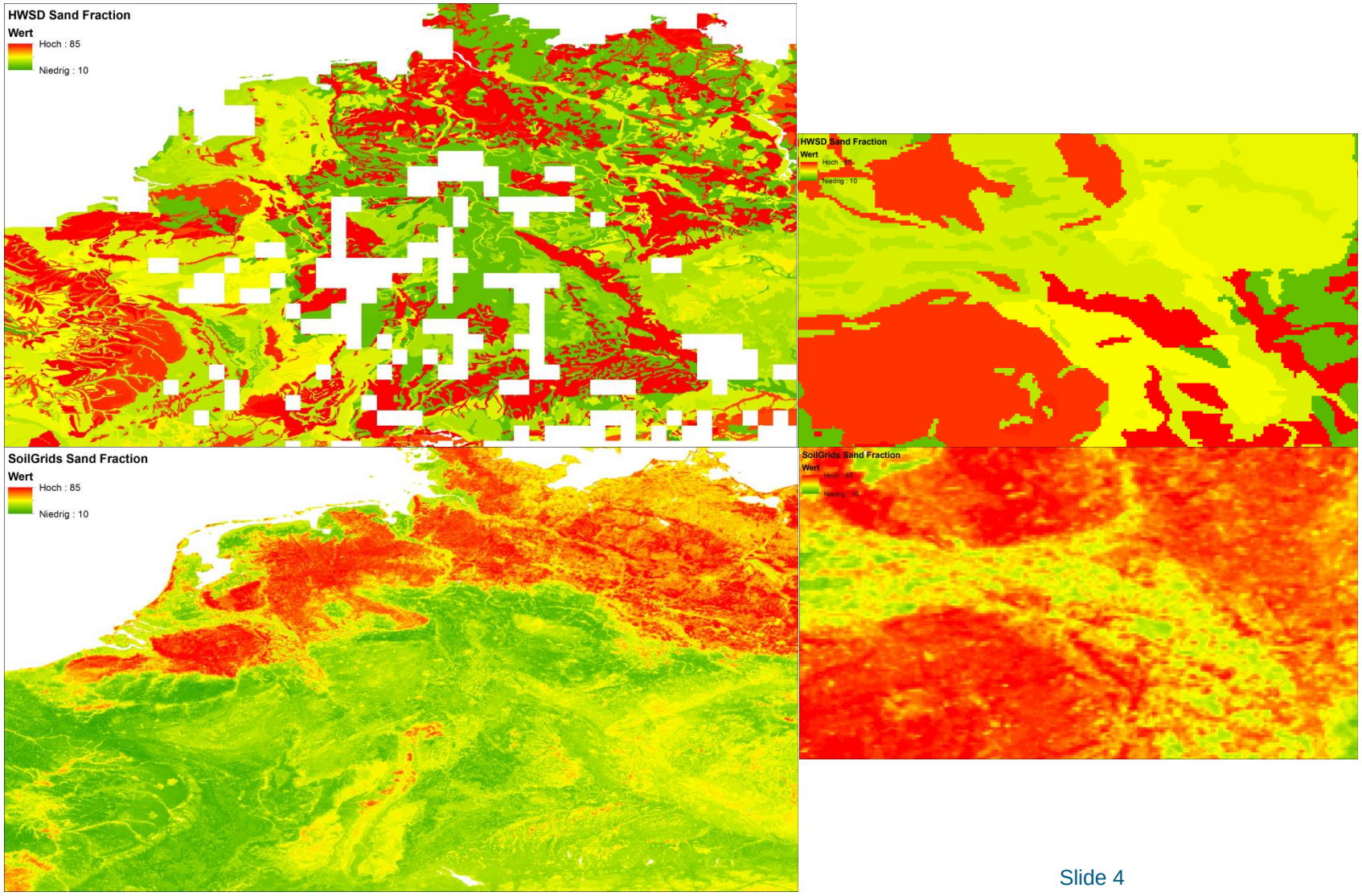
SoilGrids1km





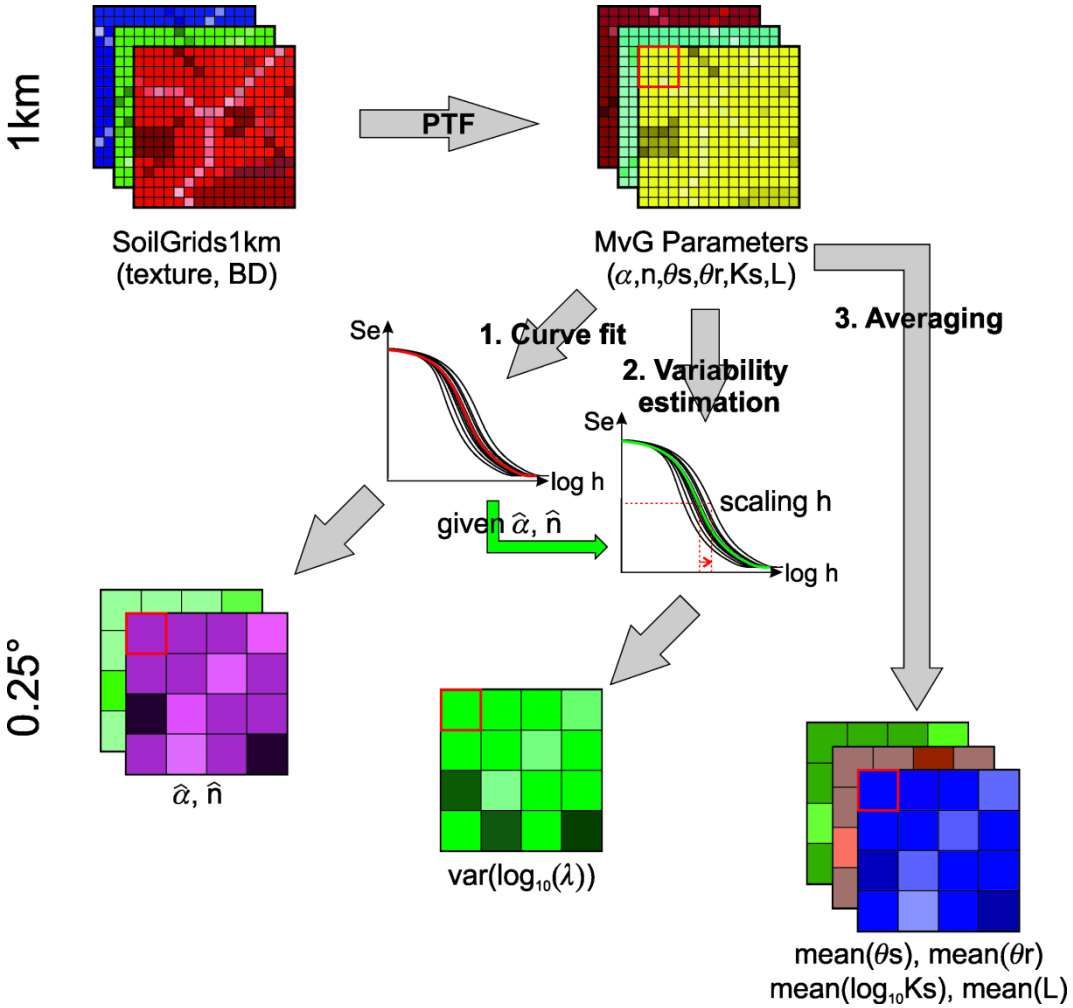
(Hengl et al., 2014)

SoilGrids1km vs. HWSD

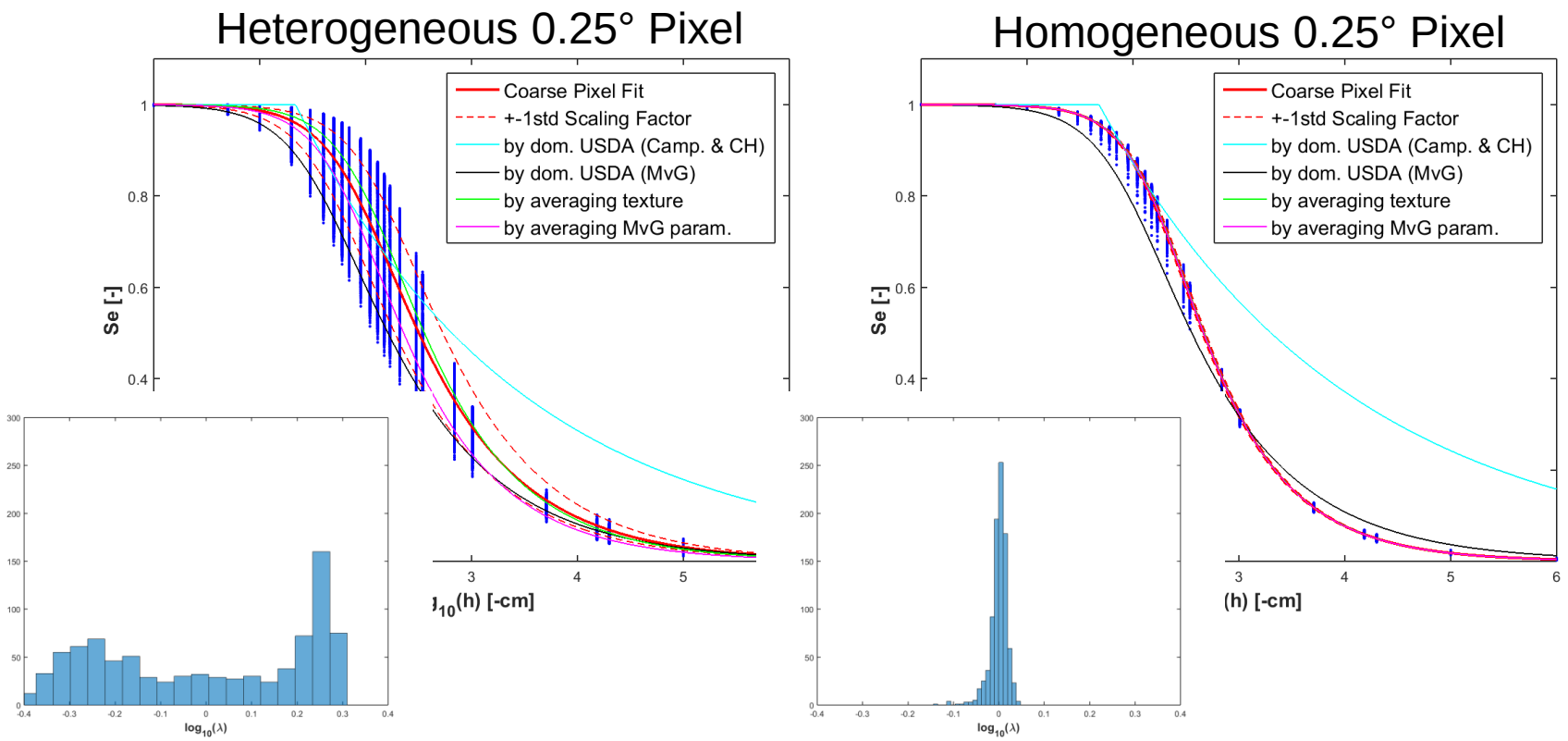


HYDRAULIC PARAMETER AND VARIABILITY PREDICTION

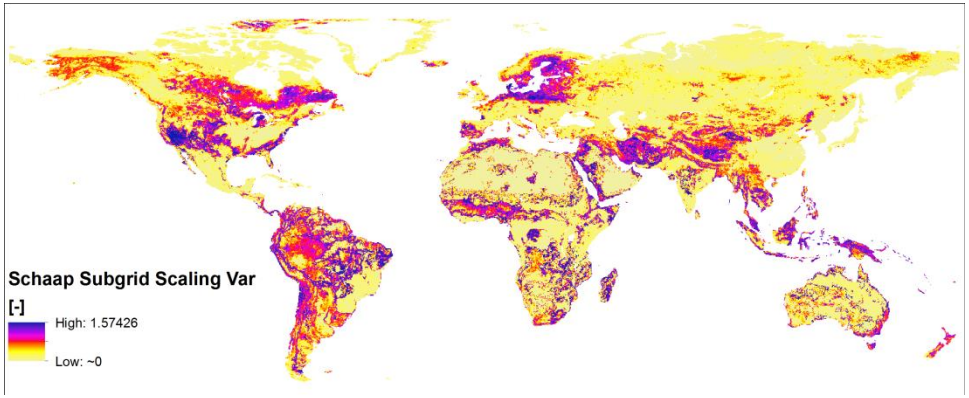
Miller-Miller (Warrick) scaling

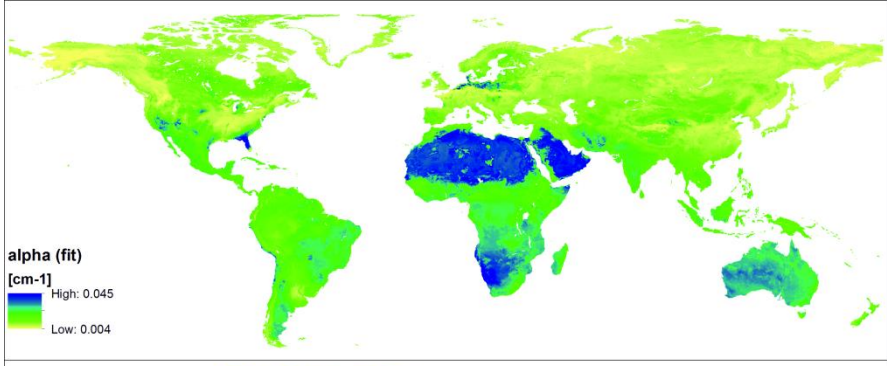


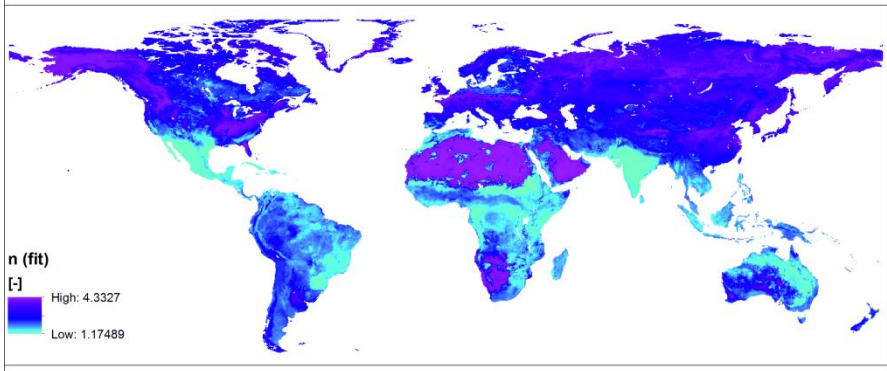
PF curves

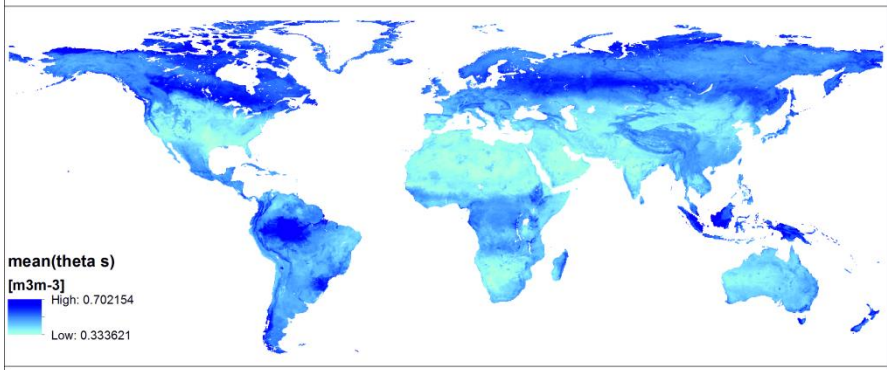

Heterogeneous 0.25° Pixel
Homogeneous 0.25° Pixel
Coarse Pixel Fit
+-1std Scaling Factor
by dom. USDA (Camp. & CH)
by dom. USDA (MvG)
by averaging texture
by averaging MvG param.
Se [-]
(h) [-cm]
log10(λ)

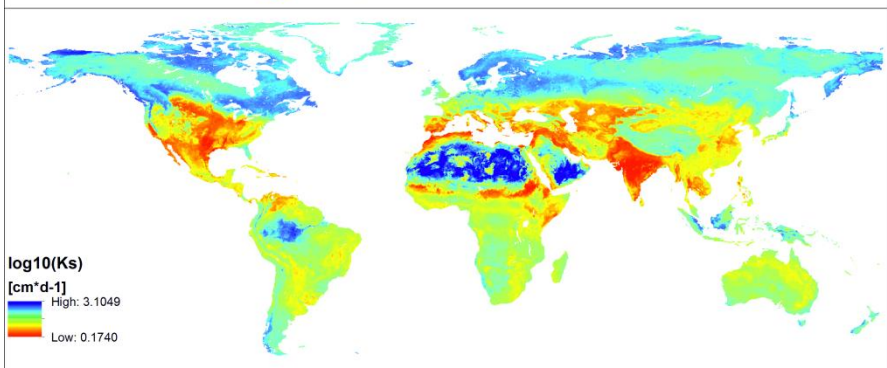
Optimized MvG maps





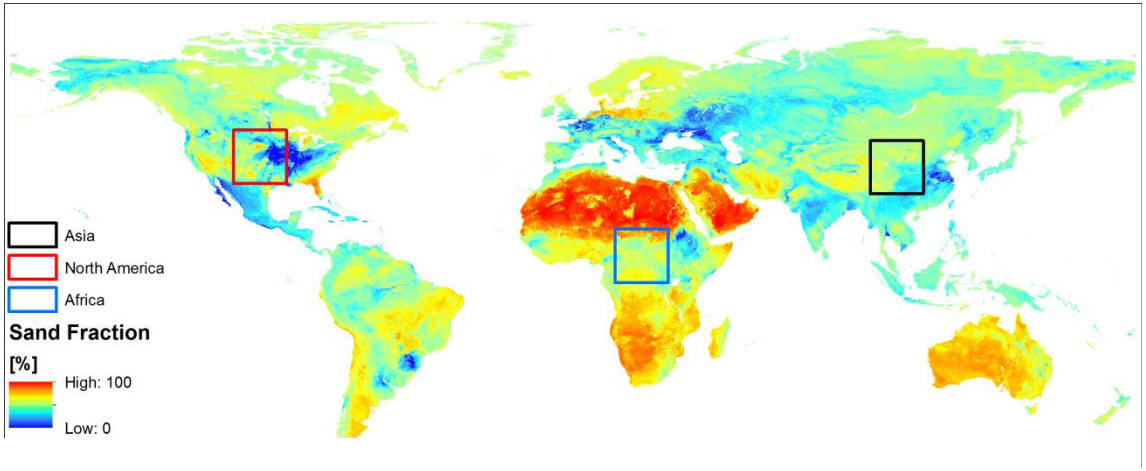


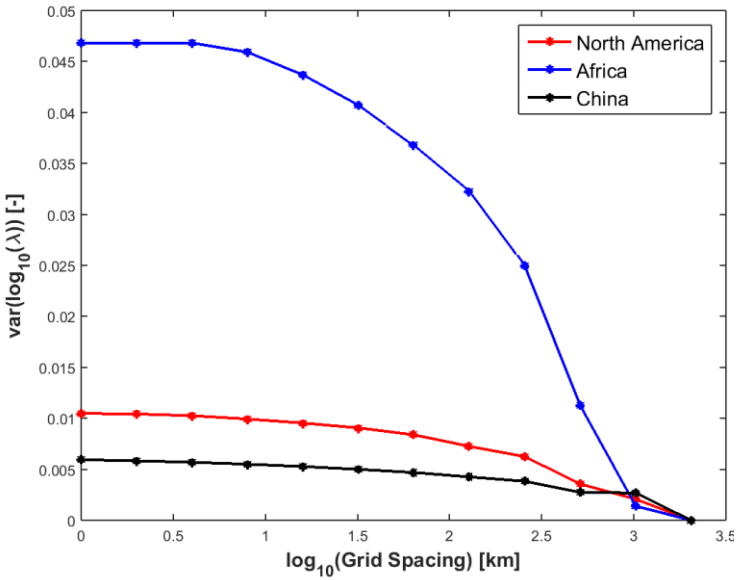


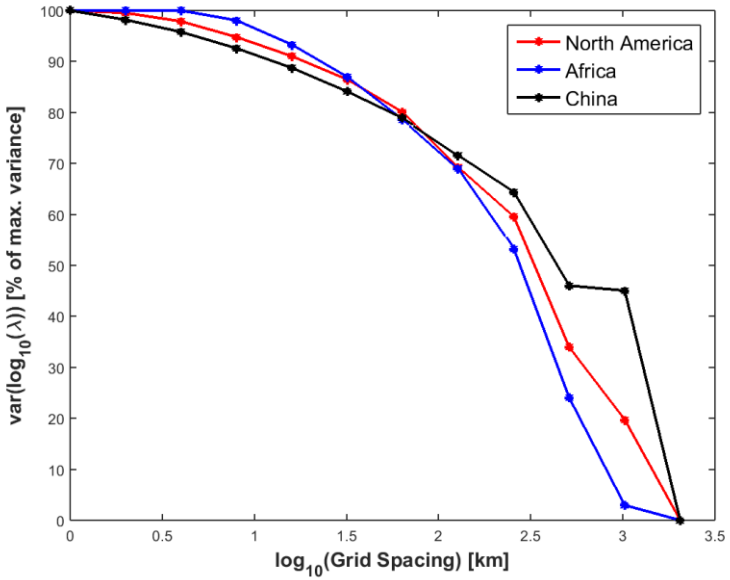


Estimate scaling loss

We are losing 10% of the variance at 16 km grid size, 20% at 64 km, and 30% at 128 km







Global soil hydraulic properties

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Open Access Earth System Science Data

A global data set of soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves

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[2]University of Reading, Department of Geography and Environmental Science, Reading, UK
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Abstract. Agroecosystem models, regional and global climate models, and numerical weather prediction models require adequate parameterization of soil hydraulic properties. These properties are fundamental for describing and predicting water and energy exchange processes at the transition zone between solid earth and atmosphere, and regulate evapotranspiration, infiltration and runoff generation. Hydraulic parameters describing the soil water retention (WRC) and hydraulic conductivity (HCC) curves are typically derived from soil texture via pedotransfer functions (PTFs). Resampling of those parameters for specific model grids is typically performed

Global soil hydraulic properties

PANGAEA.

Data Publisher for Earth & Environmental Science

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SEARCH SUBMIT ABOUT CONTACT

Citation:

Montzka, Carsten; Herbst, Michael; Weihermüller, Lutz; Verhoef, Anne; Vereecken, Harry (2017): A global data set of soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves, link to model result files in NetCDF format. *PANGAEA*, https://doi.org/10.1594/PANGAEA.870605,

Supplement to: Montzka, C et al. (2017): A global data set of soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves. *Earth System Science Data*, **9(2)**, 529-543, https://doi.org/10.5194/essd-9-529-2017

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Abstract:

Climate and numerical weather prediction models, re-analyses, as well as agroecosystem models, require adequate parameter values for soil hydraulic properties (describing e.g. the shape of the soil water retention and hydraulic conductivity curves) at the global scale. Resampling of soil hydraulic properties to a model grid is typically performed by different aggregation approaches such a spatial averaging and the use of dominant textural properties or soil classes. These aggregation approaches introduce imprecision and parameter value discrepancies throughout spatial scales due to nonlinear shape of the hydraulic conductivity and water retention curves. Therefore, we developed a method to scale van Genuchten hydraulic parameters (theta_s, theta_r, alpha, n, Ks) to individual model grids and provide a global data set that overcomes the mentioned problems. The data set is based on the ROSETTA pedotransfer function of Schaap et al. (2001, doi:10.1016/S0022-1694(01)00466-8) applied to the SoilGrids1km data set of Hengl et al. (2014, doi:10.1371/journal.pone.0105992). The approach is based on Miller-Miller scaling that fits the shape parameters of the water retention curve to all sub-grid water retention curves to provide the best-fit parameter values for the grid cell at model resolution, here 0.25°; at the same it maintains the information of sub-grid variability of the water retention curve by deriving local scaling parameters. Based on the Mualem van Genuchten approach we also derive the unsaturated hydraulic conductivity from the water retention functions, thereby assuming that the local scaling parameters are also valid for this function. In addition, information on global sub-grid scaling variance is given that enables modelers to improve dynamical downscaling of (regional) climate models or to perturb soil hydraulic parameters for model ensemble generation. These improvements should allow for more informed studies of the effects of variability in soil physical properties on land surface-atmosphere exchange.

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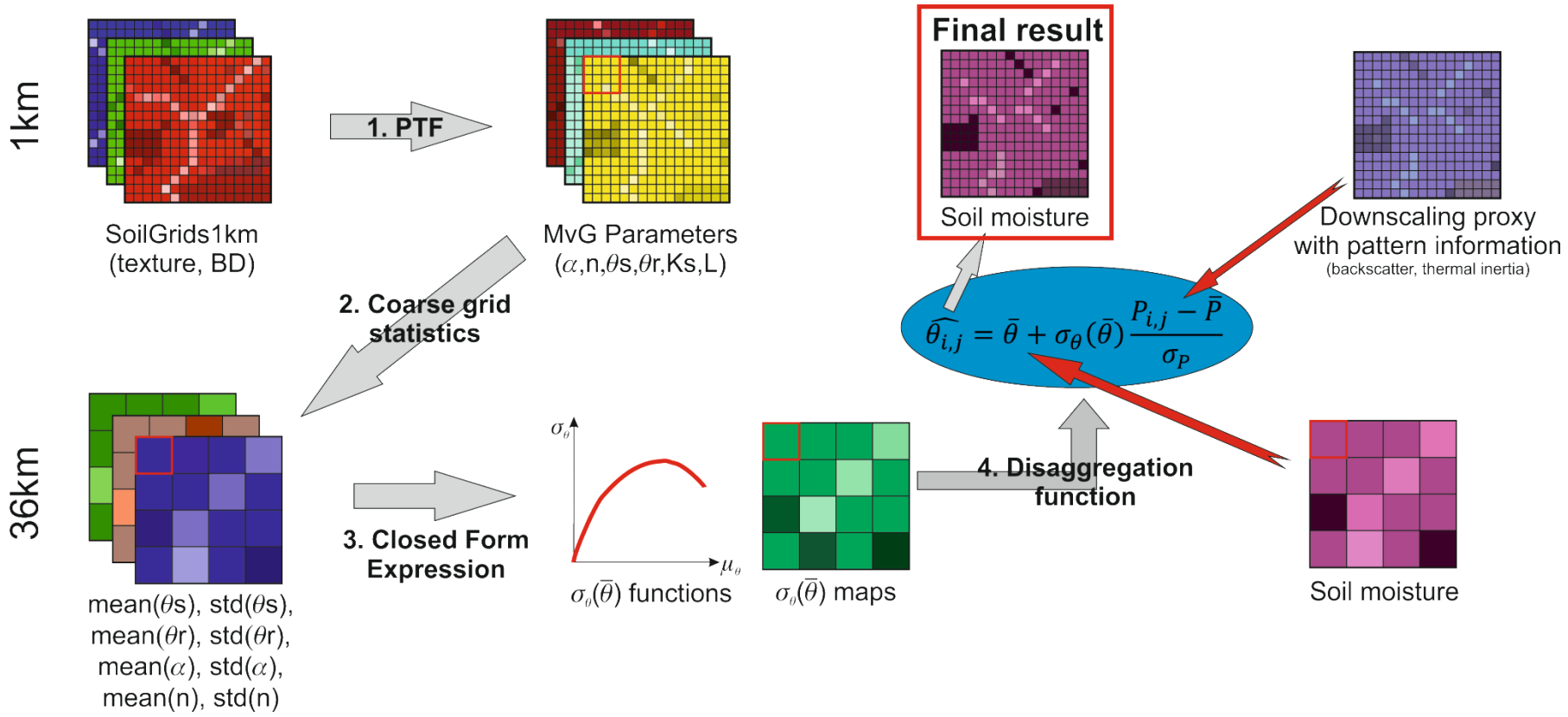
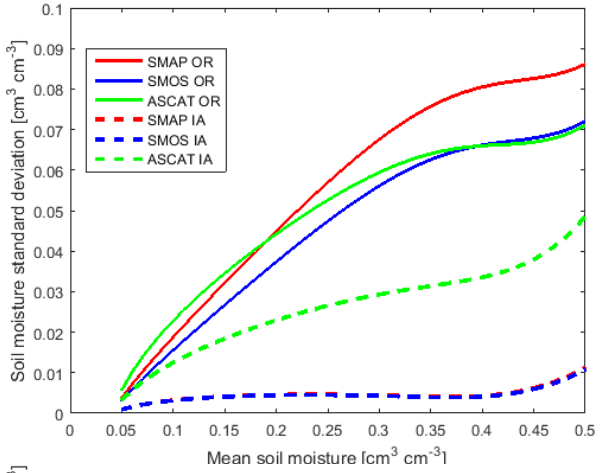
Size: 40.0 MBytes

PREDICTING SMAP, SMOS, ASCAT SUB-GRID SM VARIABILITY

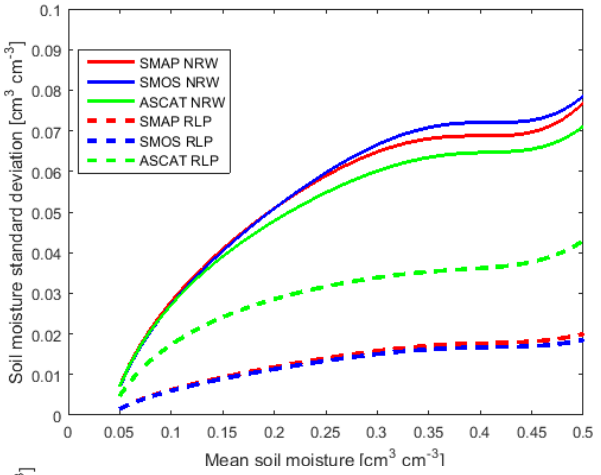
Predicting sub-grid sm variability for downscaling

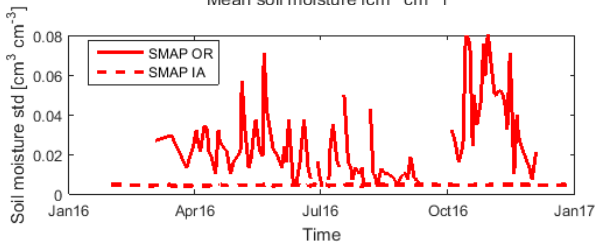


Sub-grid variability predictions for selected pixels

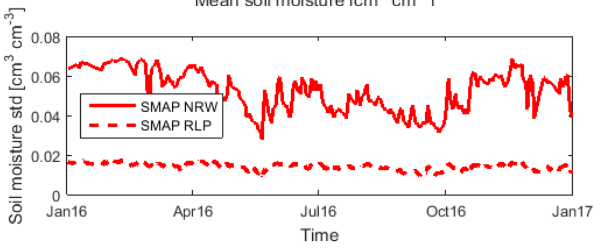


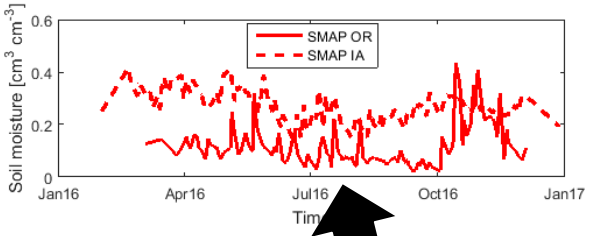
$\sigma_\theta(\bar{\theta})$ functions for different satellite grid cells at German locations (right) and for US locations (left)

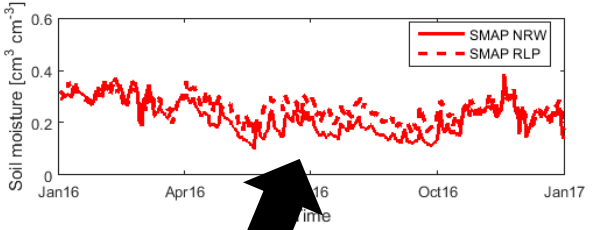




SMAP sm time series for NRW and RLP (right) and OR and IA (left) including the respective sm std time series



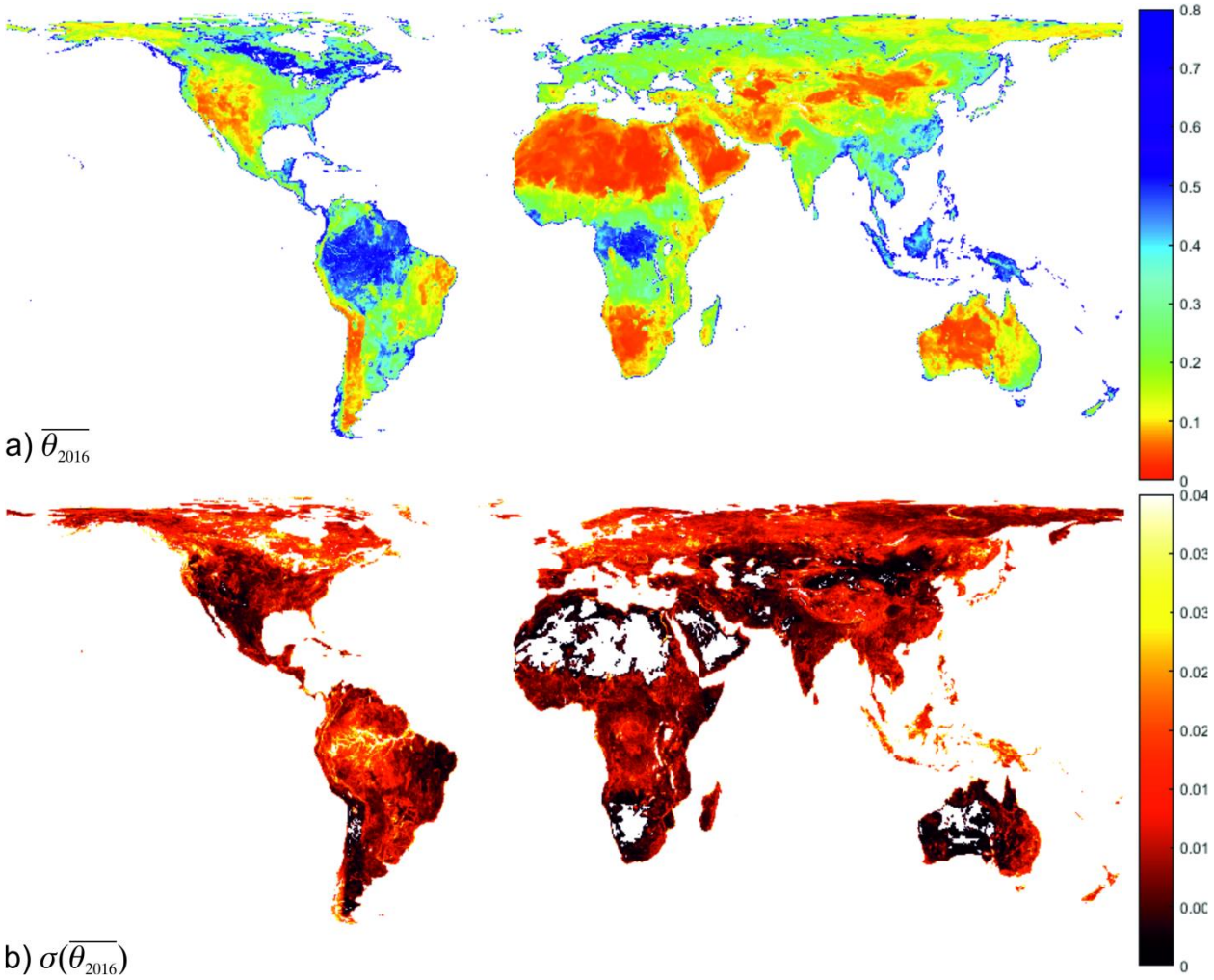




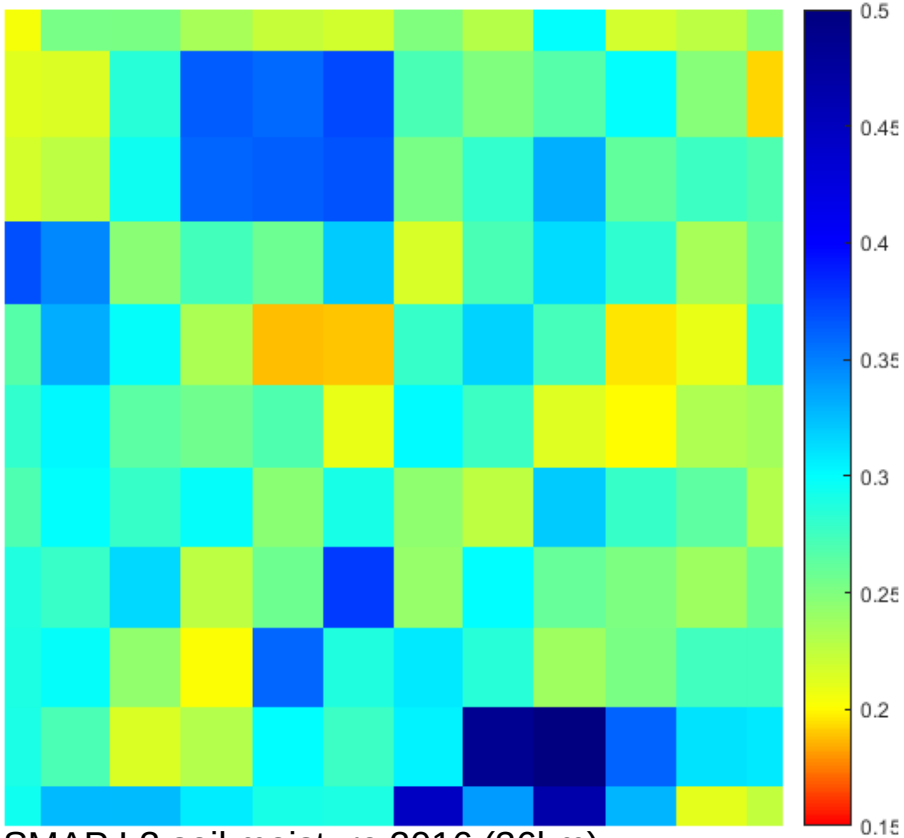
SMAP sub-grid variability

(a) SMAP soil moisture annual mean for the year 2016

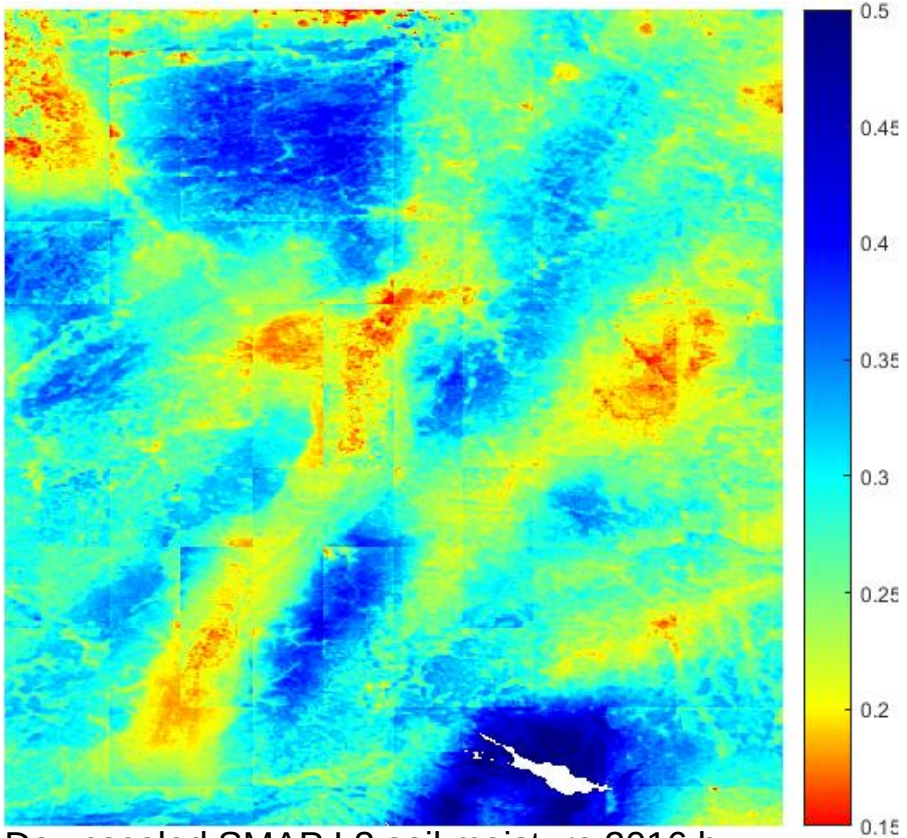
(b) SMAP sub-grid soil moisture standard deviation at 2016 mean soil moisture



Downscaling SMAP (SW Germany Example)



SMAP L3 soil moisture 2016 (36km)



Downscaled SMAP L3 soil moisture 2016 by field capacity (1km)

Conclusions

- Real pixel-based soil maps at high spatial resolution available
- Sub-grid variability of relatively coarse scale NWP, climate models or soil moisture remote sensing predictable
- Sub-grid variability can be used for ensemble generation

Thank you!

SoilGrids1km variable accuracy

Variable name	Type	GSIF code	Units	Range (observed)	Amount of var. explained
Soil organic carbon (dry combustion)	3D	ORCDRC	g kg−1	0–450	22.9%
pH index (H2O solution)	3D	PHIH5X	10−1	2.1–11.0	50.5%
Sand content (gravimetric)	3D	SNDPPT	kg kg−1	1–94	23.5%
Silt content (gravimetric)	3D	SLTPPT	kg kg−1	2–74	34.9%
Clay content (gravimetric)	3D	CLYPPT	kg kg−1	2–68	24.4%
Coarse fragments (volumetric)	3D	GRAVOL	cm3 cm−3	0–89	-
Bulk density (fine earth fraction)	3D	BLDVOL	kg m−3	250–2870	31.8%
Cation-exchange capacity (fine earth fraction)	3D	CEC	cmol+/kg	0–234	29.4%
Depth to bedrock	2D	DBR	cm	0–240	-
Soil group (WRB taxonomy)	2D	TAXGWRB	-	-	28.1% (kappa)
Soil suborder (USDA taxonomy)	2D	TAXOKST	-	-	40.3% (kappa)

WRB = "World Reference Base"; USDA = "United States Department of Agriculture".
Amount of variation explained by the models (Eq.5) i.e. kappa statistics for soil types was determined using 5-fold cross-validation.

(Hengl et al., 2014)